

Applicant : Mark A. Schubert et al.
Serial No. : 10/033,830
Filed : December 20, 2001
For : Seal for Electrochemical Cell

Art Unit: 1746
Examiner: Monique M. Wills

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CLAIM AMENDMENTS

1. (currently amended) An electrochemical cell comprising a metal container with an open end; a negative electrode, a positive electrode and an electrolyte disposed within the container; and a seal member disposed in the open end of the container for closing the cell, thereby sealing the electrodes and the electrolyte within the container; wherein the seal member comprises an injection-molded thermoplastic material, the thermoplastic material comprising a mixture of:

a ~~polyolefin~~-polypropylene matrix comprising more than 30 weight percent of the thermoplastic material; and

an aromatic polymer ~~having a repeating unit that comprises at least one aromatic functional group~~, the aromatic polymer comprising at least one polymer selected from the group consisting of poly(phenylene oxides) and polystyrenes.

2. (cancelled)

3. (cancelled)

4. (currently amended) The electrochemical cell as defined in ~~claim 3~~ claim 1, wherein the aromatic polymer comprises discrete phases in the ~~polyolefin~~-polypropylene matrix.

5. (cancelled)

6. (currently amended) The electrochemical cell as defined in ~~claim 5~~ claim 1, wherein the aromatic polymer is a poly(phenylene oxide).

7. (original) The electrochemical cell as defined in claim 1, wherein the aromatic polymer comprises an impact modifier.

8. (currently amended) The electrochemical cell as defined in claim 7, wherein the impact modified aromatic polymer comprises discrete phases in the ~~polyolefin~~ polypropylene matrix.

9. (original) The electrochemical cell as defined in claim 7, wherein the impact modifier is a styrene/polyolefin block copolymer.

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10. (original) The electrochemical cell as defined in claim 1, wherein the thermoplastic material further comprises a compatibilizer.
11. (currently amended) The electrochemical cell as defined in claim 10, wherein the compatibilizer comprises a block copolymer having at least one block, wherein a first block end is soluble in the ~~polyolefin~~ polypropylene and a second block end is soluble in the aromatic polymer.
12. (currently amended) The electrochemical cell as defined in claim 1, wherein the ~~polyolefin-polypropylene~~ comprises no more than 95 weight percent of the thermoplastic material.
13. (currently amended) The electrochemical cell as defined in claim 1, wherein the ~~polyolefin-polypropylene~~ comprises at least 40 weight percent of the thermoplastic material.
14. (currently amended) The electrochemical cell as defined in claim 13, wherein the aromatic polymer comprises polystyrene and the ~~polyolefin-polypropylene~~ comprises at least 50 weight percent of the thermoplastic material.
15. (original) The electrochemical cell as defined in claim 13, wherein the aromatic polymer comprises poly(phenylene oxide).
16. (original) The electrochemical cell as defined in claim 1, wherein the seal material is made from a mixture of polypropylene and poly(phenylene oxide).
17. (original) The electrochemical cell as defined in claim 1, wherein the electrolyte is an alkaline aqueous solution.
18. (original) The electrochemical cell as defined in claim 17, wherein the negative electrode comprises zinc, the positive electrode comprises manganese dioxide, and the electrolyte comprises a potassium hydroxide.

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19. (original) The electrochemical cell as defined in claim 1, wherein:
the cell further comprises a cover, a current collector and a contact terminal;
the cover is disposed in the open end of the container;
the current collector is electrically connected to one of the electrodes and extends through an aperture in the seal member so as to be electrically connected to the contact terminal;
the seal member forms a compressive seal between the container and the cover, and the seal member comprises a hub that forms a compressive seal around the current collector.
20. (original) The electrochemical cell as defined in claim 19, wherein the hub is not compressed between the cover and the current collector.
21. (original) The electrochemical cell as defined in claim 1, wherein the thermoplastic material has a tensile creep deformation, between 1 and 1000 hours at 114°F under a constant load of 1500 psi, of 0 to 3 percent, as determined by ASTM D2990.
22. (original) The electrochemical cell as defined in claim 21, wherein the thermoplastic material has a tensile modulus of 100,000 to 400,000 psi, as determined by ASTM D638.
23. (original) The electrochemical cell as defined in claim 22, wherein the thermoplastic material has a tensile modulus of 100,000 to 250,000 psi.
24. (original) The electrochemical cell as defined in claim 1, wherein the thermoplastic material has a coefficient of thermal expansion in the direction of flow of 0.000010 to 0.00020 in/in-°F at 50% RH and 73°F, as determined by ASTM E831.
25. (original) The electrochemical cell as defined in claim 21, wherein the thermoplastic material has a heat deflection temperature at 66 psi of 200°F to 400°F, as determined by ASTM D648.
26. (original) The electrochemical cell as defined in claim 25, wherein the thermoplastic material has a heat deflection temperature at 66 psi of 230°F to 400°F.

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27. (original) The electrochemical cell as defined in claim 1, wherein the seal member further comprises a pressure relief mechanism that ruptures to release internal pressure from the cell and the thermoplastic material has a tensile elongation to break of 20-350 percent, as determined by ASTM D638.

28. (currently amended) ~~An electrochemical cell comprising a container with an open end; a negative electrode, a positive electrode and an electrolyte disposed within the housing; and a seal member disposed in the open end of the container for closing the cell, thereby sealing the electrodes and the electrolyte within the container; wherein the seal member comprises an injection molded thermoplastic material, the thermoplastic material comprising a mixture of:~~
~~—— a polyolefin matrix comprising more than 30 weight percent of the thermoplastic material; and~~
~~—— an aromatic polymer having a repeating unit that comprises at least one aromatic functional group;~~

The electrochemical cell as defined in claim 1, wherein the thermoplastic material has a heat deflection temperature at 66 psi of 200°F to 400°F, as determined by ASTM D648.

29. (original) The electrochemical cell as defined in claim 28, wherein the thermoplastic material has a tensile creep deformation, between 1 and 1000 hours at 114°F under a constant load of 1500 psi, of 0 to 3 percent, as determined by ASTM D2990.

30. (original) The electrochemical cell as defined in claim 29, wherein the thermoplastic material has a tensile modulus of 100,000 to 400,000 psi, as determined by ASTM D638.

31. (currently amended) A seal member for an electrochemical cell, wherein the seal member is capable of forming a compressive seal and comprises an injection molded thermoplastic material comprising a mixture of:

a polyolefin polypropylene matrix comprising more than 30 weight percent of the thermoplastic material; and

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~~an aromatic polymer having a repeating unit that comprises at least one aromatic functional group, the aromatic polymer comprising at least one polymer selected from the group consisting of poly(phenylene oxides) and polystyrenes.~~

32. (currently amended) The seal member as defined in claim 31, wherein:

~~the polyolefin is at least one polymer selected from the group consisting of a polypropylene, a polyethylene, and a polypropylene-ethylene copolymer;~~

~~the aromatic polymer is at least one polymer selected from the group consisting of poly(phenylene oxides), aramids, polyketones, polysulfones, polystyrenes, polybenzimidazoles, polyimides, polybenzoxazinones, polybenzothiazoles, polybenzoxazoles, polybenzimidazoles, polyarylates, polyamide-imides, polyetherimides, polyphenylene sulfides, polyphenyls, polyquinelines and polyquinoxalines;~~

~~the thermoplastic material has a heat deflection temperature at 66 psi of 200°F to 400°F, as determined by ASTM D648;~~

~~the thermoplastic material has a tensile creep deformation, between 1 and 1000 hours at 114°F under a constant load of 1500 psi, of less than 3 percent, as determined by ASTM D2990; and~~

~~the thermoplastic material has a tensile modulus of 100,000 to 400,000 psi, as determined by ASTM D638.~~

33. (cancelled)

34. (currently amended) The seal member as defined in ~~claim 33~~ claim 31, wherein the aromatic polymer is poly(phenylene oxide).

35. (original) The seal member as defined in claim 34, wherein the aromatic polymer further comprises an impact modifier and the thermoplastic material further comprises a compatibilizer.

36. (original) An electrochemical cell comprising a metal container and an injection-molded thermoplastic seal member forming a compressive seal, wherein the seal member has:

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a tensile creep deformation, between 1 and 1000 hours at 114°F under a constant load of 1500 psi, of 0 to 3 percent, as determined by ASTM D2990;

a tensile modulus at 50% RH and 23°C of 120,000 to 300,000 psi, as determined by ASTM D638;

a coefficient of thermal expansion in the direction of flow at 50% RH and 73°F of 0.000020 to 0.000060 in./in.-°F, as determined by ASTM E831; and

a heat deflection temperature, dry as molded, at 66 psi of 230 °F to 400°F, as determined by ASTM D648.

37. (original) The electrochemical cell as defined in claim 36, wherein the seal member comprises a pressure relief mechanism and has a tensile elongation to break of 30 to 200 percent, as determined by ASTM D638.

38. (original) The electrochemical cell as defined in claim 37, wherein the seal member is made from a mixture comprising:

more than 30 weight percent polyolefin, the polyolefin comprising at least one polymer selected from the group consisting of a polypropylene, a polyethylene, and a polypropylene-ethylene copolymer; and

an aromatic polymer, the aromatic polymer comprising at least one polymer selected from the group consisting of poly(phenylene oxides) and polystyrenes.

39. (new) The electrochemical cell as defined in claim 1, wherein the thermoplastic material has a tensile creep deformation, between 1 and 1000 hours at 114°F under a constant load of 1500 psi, of 0 to 3 percent.

40. (new) The electrochemical cell as defined in claim 39, wherein the thermoplastic material has a tensile modulus of 100,000 to 400,000 psi.

41. (new) The electrochemical cell as defined in claim 40, wherein the thermoplastic material has a tensile modulus of 100,000 to 250,000 psi.

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42. (new) The electrochemical cell as defined in claim 1, wherein the thermoplastic material has a coefficient of thermal expansion in the direction of flow of 0.000010 to 0.00020 in/in-°F at 50% RH and 73°F.
43. (new) The electrochemical cell as defined in claim 39, wherein the thermoplastic material has a heat deflection temperature at 66 psi of 200°F to 400°F.
44. (new) The electrochemical cell as defined in claim 43, wherein the thermoplastic material has a heat deflection temperature at 66 psi of 230°F to 400°F.
45. (new) The electrochemical cell as defined in claim 1, wherein the seal member further comprises a pressure relief mechanism that ruptures to release internal pressure from the cell and the thermoplastic material has a tensile elongation to break of 20-350 percent.
46. (new) The electrochemical cell as defined in claim 1, wherein the thermoplastic material has a heat deflection temperature at 66 psi of 200°F to 400°F.
47. (new) The seal member as defined in claim 31, wherein:
the thermoplastic material has a heat deflection temperature at 66 psi of 200°F to 400°F;
the thermoplastic material has a tensile creep deformation, between 1 and 1000 hours at 114°F under a constant load of 1500 psi, of less than 3 percent; and
the thermoplastic material has a tensile modulus of 100,000 to 400,000 psi.
48. (new) The seal member as defined in claim 47, wherein the aromatic polymer is poly(phenylene oxide).
49. (new) The seal member as defined in claim 48, wherein the aromatic polymer further comprises an impact modifier and the thermoplastic material further comprises a compatibilizer.
50. (new) An electrochemical cell comprising a metal container and an injection-molded thermoplastic seal member forming a compressive seal, wherein the seal member has:

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a tensile creep deformation, between 1 and 1000 hours at 114°F under a constant load of 1500 psi, of 0 to 3 percent;

a tensile modulus at 50% RH and 23°C of 120,000 to 300,000 psi;

a coefficient of thermal expansion in the direction of flow at 50% RH and 73°F of 0.000020 to 0.000060 in./in.-°F; and

a heat deflection temperature, dry as molded, at 66 psi of 230 °F to 400°F.

51. (new) The electrochemical cell as defined in claim 50, wherein the seal member comprises a pressure relief mechanism and has a tensile elongation to break of 30 to 200 percent.

52. (new) The electrochemical cell as defined in claim 51, wherein the seal member is made from a mixture comprising:

more than 30 weight percent polyolefin, the polyolefin comprising at least one polymer selected from the group consisting of a polypropylene, a polyethylene, and a polypropylene-ethylene copolymer; and

an aromatic polymer, the aromatic polymer comprising at least one polymer selected from the group consisting of poly(phenylene oxides) and polystyrenes.